Development of a Programmable Electronic Digital Code lock system

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Abstract— **Technological advancement has been consistently and constantly made on various electronic devices with little or no emphasis on locking systems. Unlimited access and absolutely no hindrance to data, file usage, automobile car, and bank safes e.t.c by intruders has necessitated the need for a programmable electronic code lock system. This programmable electronic code lock system is an integrated combination lock which is programmed and responds only to the right sequences of digit that is keyed in. The basic objective of this design is to provide a security measure in an automobile car, this is achieved through the ignition part of the automobile car which is used to engage and disengage the engine from cranking in order to put the car in motion.**

Keywords-implementation, programmable, electronic, digital code lock system, ignition

I. INTRODUCTION

Security of human life and property is one of the paramount challenges facing any nation or any corporate organization. Also, ensuring safety and confidentiality of data & message stored in a system or electrical appliances is quite essential to prevent unauthorized access. The design and construction of a programmable electronic digital code lock system provides a sure way of ensuring this security and safety for data. Programmable digital code lock system is a high security code lock system that can be used to lock electronic devices such as Television set, computer system and other electrical appliances [5]. In this paper, the digital code lock was used as a security measure in an automobile car, achieved through the ignition part of the automobile car which is used to engage and disengage the engine from cranking in order to put the car in motion.

This system is a combination of hardware and software at its best. In this design, a device is locked using a six digit code (password). The code can be set according to the user's desire, hence the name "PROGRAMMABLE". The electronic code lock locks up the system by switching to alarm mode when any wrong code is entered for four consecutive times and allows the user to start it only when a proper 6-digit code is entered in the correct sequence.

II. METHODOLOGY

In this paper, a digital code lock system was designed as a security measure in an automobile. It can however, be implemented for locking electronic devices such as Television set, computer system and other electrical appliances [9]. The system consists of a hardware module and an application program for microcontroller unit. The block diagram of which is as shown in figure 1.

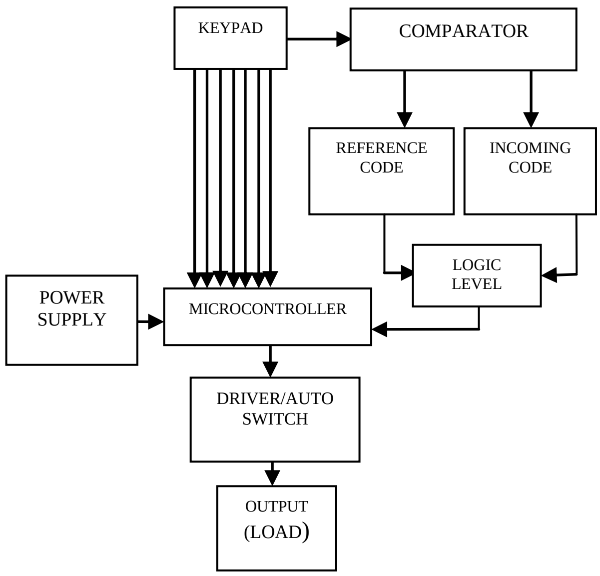


Fig 1: Block diagram of a programmable electronic lock

The hardware module comprises four stages: the power supply unit, the keypad, the microcontroller, and the comparator.

A. Power Supply Stage

The whole design is powered with a 5V dc supply. Herein, a regulated dc voltage is obtained from the mains' 220VAC. A step down transformer is used to step down the 220VAC to 18VAC. The 18VAC is rectified to obtain a dc voltage required to power the digital circuitry [2, 10]. Since the microcontroller requires a 5 - Volt supply, a voltage regulator (78L05) is used to regulate the rectified, filtered 18VDC to 5VDC desired. Figure 2 shows the power supply stage for this design.

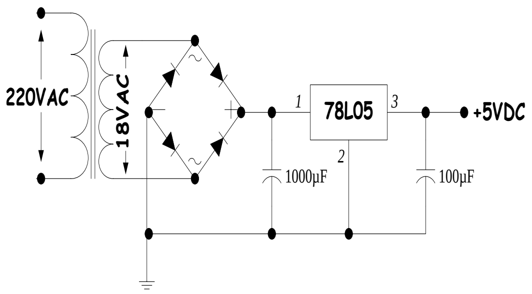


Figure 2: Power supply stage

B. The Keypad

This is the input unit. It consists of digital devices such as switches, push buttons, pressure mats and float switches. Keypads are an excellent way of entering data into microcontroller. The keys are usually numbered but they can also be labeled as function keys, for example in the remote control handset of a TV to adjust the sound or color, etc. Like remote controls, keypads find applications in burglar alarms, door entry systems, calculators and microwave ovens. Keypads are usually arranged in a matrix format to reduce the number of input/output connections [1]. A 12 key-keypad is arranged in a 3 x 4 format requiring seven connections while a 16 key-keypad is arranged in a 4 x 4 format requiring eight connections. The former was used in this design.

C. Microcontroller Stage

The microcontroller stage is implemented by using the PIC16F84A. It is preferred because of its popularity, versatility, availability and simplicity to comprehend [3]. PIC16F84 belongs to a class of 8-bit microcontrollers of RISC architecture. It is an 18 pin dual in-line package chip.
On the PIC16F84A, there are 68 bytes of general-purpose RAM, located at addresses C to hex 4F. Besides the general-purpose memory, there is a special "working register" "or register" where the CPU holds the current data. There are also several special function registers each of which controls the operation of the PIC in some way. The program memory of the PIC16F84A consists of flash EPROM; it can be recorded and erased electronically, and it retains its contents when powered off.
There are two input- output ports, port A and port B, and each pin of each port can be set individually as an input or an output. The bits of each port are numbered, starting at 0. In output mode, bit 4 of port A has an open collector (or rather open drain); the rest of the outputs are regular CMOS [4]. The CPU treats each port as one 8-bit byte of data even though only five bits of port A are actually brought out as pins of the IC. PIC inputs are CMOS-compatible; PIC outputs can drive TTL or CMOS logic chips: Each output pin can source or sink 20mA as long as only one pin is doing so at a time. The figure 5 shows the general circuit diagram of the digital code lock system.

- Pin Description of the PIC16F84AP

  Figure 3 shows pin description of PIC16F84, it has a total of 18 pins. It is most frequently found in a DIP18 type of case but can also be found in SMD case which is smaller from a Dual-in-line (DIP) Package. SMD is an abbreviation for Surface Mount Devices suggesting that holes for pins to go through when mounting, are not necessary in soldering this type of a component.
  Pins on P1C16F84A microcontroller have the following functions [8,11]
  Pin no. 1: *RA2,* second pin on port A. It has no additional function.
  Pin no. 2: *RA3,* third pin on port A. It has no additional function.
  Pin no. 3: *RA4,* fourth pin on port A. TOCK1, which functions as a timer, is also found on this pin.

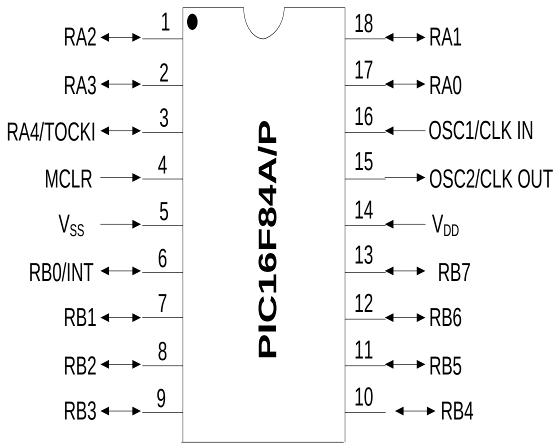
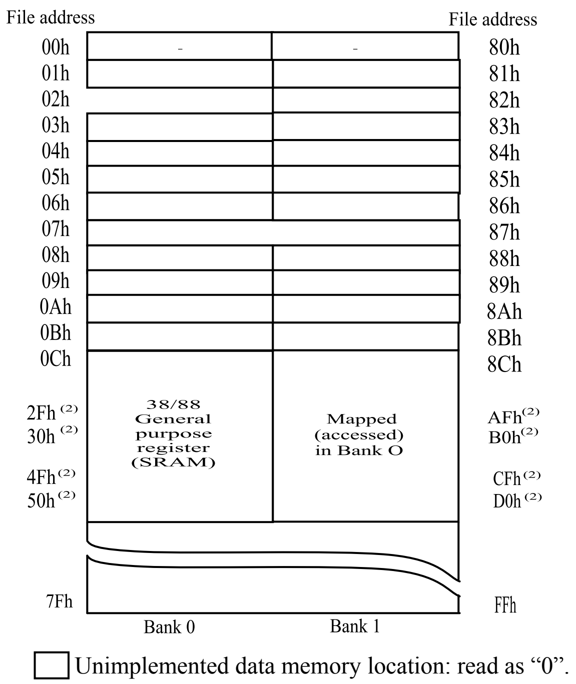


Figure 3: Pin out orientation of the PIC16F84A.

Pin no. 4: MCLR Reset input and Vpp programming voltage of a microcontroller.
Pin no. 5: $V_{SS,}$ Ground of power supply.
Pin no. 6: RBO, Zero pin on port B. Interrupt input is an additional function.
Pin no. 7: RBI, First pin on port B. It has no additional function.
Pin no. 8: RB2, Second pin on port B. It has no additional function.
Pin no. 9: RB3, Third pin on port B. It has no additional function.

Pin no. 10: RB4, Fourth pin on port B. It has no additional function.
Pin no. 11: RB5, Fifth pin on port B. It has no additional function.
Pin no. 12: RB6, Sixth pin on port B. 'Clock' line in program mode.
Pin no. 13: RBI, Seventh pin on port B. 'Data' line in program mode.
Pin no. 14: V_{DD}, Positive power supply pole.
Pin no.15: OSC2, Pin assigned for connecting with an oscillator.
Pin no. l6: OSC1, Pin assigned for connecting with an oscillator,
Pin no. 17: RA2, Second pin on port A. It has no additional function.
Pin no. 18: RA1, First pin on port A. It has no additional function.

- Program Memory
  Programs written into the microcontroller are stored in the EPROM (Electrically Programmable Read Only Memory). This memory is non volatile and is remembered when the power is switched off. The memory is electrically programmed by a piece of hardware called a programmer. The memory map of the PIC16F84 chip, a typical microcontroller, is shown in figure 4.
  The instructions written into the microcontroller work by moving and manipulating data in memory locations known as user files and registers.This memory is called RAM (Random Access Memory) [6].



Note 1: Not a physical register.
Note 2: The address depends on the device used.
Devices with 36 bytes end at 2Fh, devices with 88 bytes end at 4Fh

Figure 4: memory map of the PIC16F84A chip

D. *The comparator*

The comparator is used to verify whether the code is correct or incorrect, this is comparing the reference code with the incoming code. The reference code is the code that was originally installed on the lock system and the incoming code is the code to be entered to gain access to the system. The incoming code must match with the reference code. The comparator produces a logic level which is either a low or high level [7], if the logic level is low; this means the incoming code is not the correct code therefore the ignition system will not be activated. If the logic level is high, the incoming code is correct, therefore the ignition system will be activated. The result is then passed into the microcontroller and onward to the microcontroller to the driver/ auto switch which triggers the ignition system on or off.

III. PRINCIPLE OF OPERATION.

The code lock is six digit codes that are entered via the keypad interfaced to the microcontroller. The user enters the code via the keypad which consists of digit 0 to 9 as well as * and #. The microcontroller accepts the entered code and comparator compares it with the registered code. When the code is found to be correct, the microcontroller outputs a TTL logic signal that is used to clock a timer stage. The timer stage is implemented by using a timer/ oscillator IC (NE555) which outputs a clock that toggles the D-flip flop. The flip-flop changes states on every clock it receives and with this the security system is either enabled or disabled. Figure 5 shows the General Cicuit Diagram of Digital Code Lock.

IV. RESULT AND TESTING

The programmable electronic digital code lock system was implemented and tested by improvising for an automobile. Adequate testing procedures and precautions were observed before and after coupling elements and units together. One significant procedure ensured was that all circuit elements were set-up on a bread board for testing before being transferred to the printed circuit board (PCB) where the performance was certified. The interior and exterior parts of the system are as shown in Figures 6 and 7 respectively.
The system was tested by connecting the power cord of the device to an external power supply and then turning ON the switch of the device. The programmed code (default) was entered in order to activate the toy car for movement. As long as the correct code was entered, the car was set in motion which implies that the car cannot move except it is activated,

which is a way of ensuring the security of the car. Incorrect codes were also entered without any movement and after the third attempt the system disabled itself. Figs. 8 and 9 show the connection between the code lock and the toy car; as well as the toy car in motion respectively.

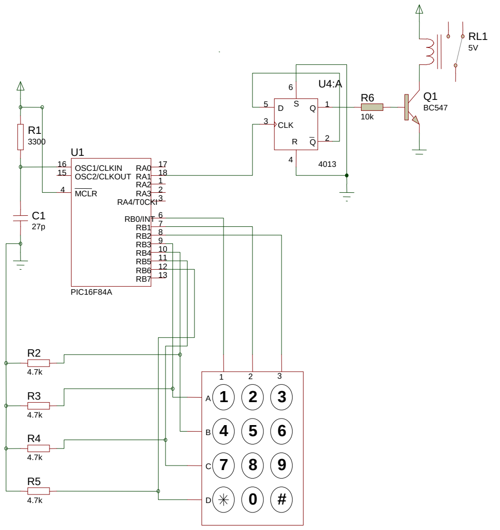


Figure 5: General Cicuit Diagram of Digital Code Lock

Figure 6: Interior part of the design

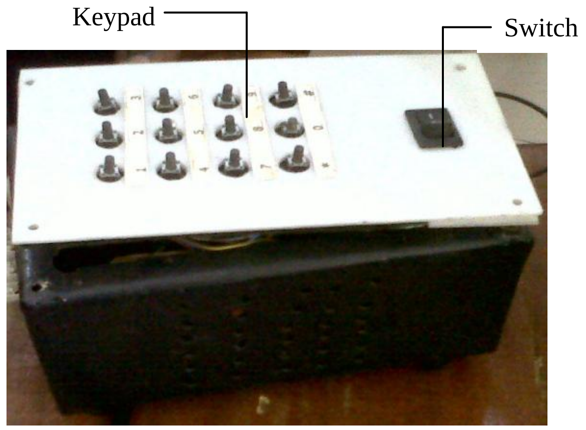


Figure 7: Exterior part of the design

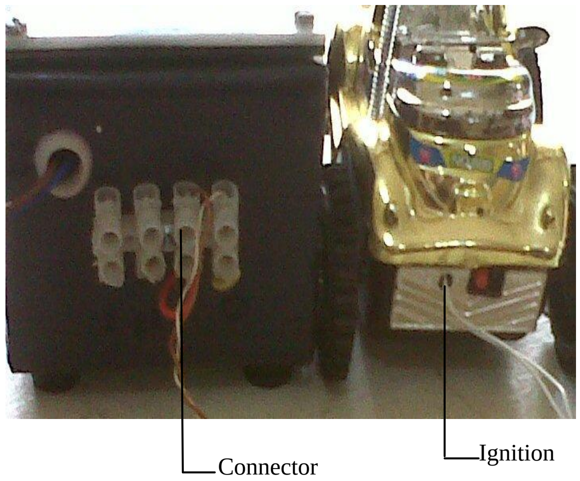


Figure 8: Connection between the code lock and the toy car

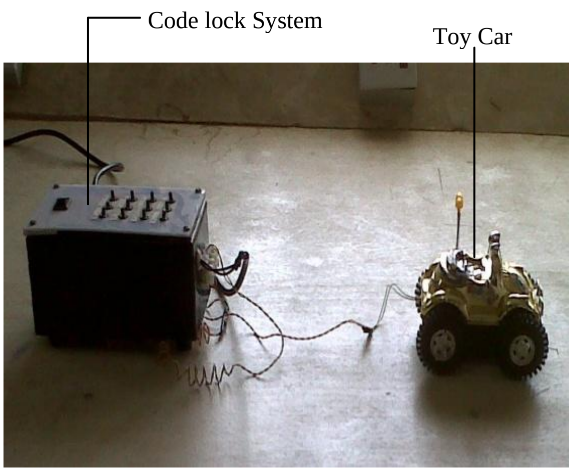


Figure 9: Toy car in motion

V. CONCLUSION

Conclusively, the challenges associated with continued production of electronic devices without a corresponding locking system has been met with the design and construction of programmable electronic digital lock. No doubt, this will serve as a measure to prolong the life span of such electronic devices and also ensure adequate safety and required protection of data, files, electronic devices and a host of facilities which include computer systems, televisions and most especially to provide a means for restricting and disallowing unauthorized user from gaining access to an automobile car through the ignition system.

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